Available online at www.sciencedirect.com
ScienceDirect
Journal of Magnetism and Magnetic Materials 310 (2007) 1966–1968
Journal of magnetism and magnetic materials
www.elsevier.com/locate/jmmm

Griffiths phases vs magnetic polarons in the lightly doped $La_{1-x}Sr_xMno_3$

V.A. Ivanshin[a,b,*], J. Deisenhofer[b], H.-A. Krug von Nidda[b], A. Loidl[b]

[a]*Physics Faculty, Kazan State University, 420008 Kazan, Russia*
[b]*EP V, Center for Electronic Correlations and Magnetism, University of Augsburg, 86135 Augsburg, Germany*

Available online 20 November 2006

Abstract

The nature of the ferromagnetic (FM)–paramagnetic (PM) transition in perovskite-doped manganites is the subject of considerable discussions. There is no general consensus about the microscopic physics of stable FM clusters within PM matrix for the temperature range around Curie temperature. Our measurements of electron-spin resonance and magnetic susceptibility in the system $La_{1-x}Sr_xMnO_3$ ($0.07 \leqslant x \leqslant 0.16$) reveal a novel triangular Griffith's-phase regime, which arises as a result of the strong quenching of the randomly diluted locations of the FM bonds in the cooperatively Jahn–Teller-distorted orthorhombic structure. However, the Griffith's singularities disappear for $x > 0.16$. In this case, an applicability of description based on magnetic polarons coupled on lattice distortions will be discussed.

PACS: 75.47.Gk; 71.70.Ej; 75.30.Et; 76.30.−v

Keywords: Manganese perovskite; Electron spin resonance; Griffith's phase; Polaron

During the past two decades, the existence of the Griffith's-phase (GP) regime [1] has been reported in different compounds with complex magnetic interactions such as spin-glasses [2], strongly correlated 4f-electron systems with the non-Fermi liquid behavior [3,4], low-dimensional magnet $CuGeO_3$:Fe [5], perovskite manganites [6–9], and rare-earth intermetallic compound $Tb_5Si_2Ge_2$ [10]. The competition between charge-ordered anti-ferromagnetic (AFM) and metallic ferromagnetic (FM) phases appears to be a significant factor for the rich phase diagrams of these systems.

Despite the large number of works, the nature of nanoscale-size inhomogeneities (stable FM clusters) in the paramagnetic (PM) regime of manganites is still an unresolved problem [11]. Very recently, the existence of Griffith's-like features has been proposed in the PM phase of the $La_{1-x}Sr_xMnO_3$ single crystals for the concentration range of Sr $0.07 \leqslant x \leqslant 0.16$, using electron-spin resonance (ESR) and magnetic susceptibility measurements [9]. These singularities, which are characterized by the coexistence of FM resonance and PM resonance signals above the magnetic ordering temperature T_c and by the deviation of susceptibility from the Curie–Weiss form, were identified as a GP regime. As an example, Fig. 1 shows the resonance positions for $x = 0.1$. The spectrum consists of strongly orientation-dependent resonance lines (in addition to the PM signal due to the majority of Mn^{3+} and Mn^{4+} spins [12] at $g \approx 2$) with unusual g values (max. $g_{eff} \approx 4$). The main PM resonance (solid squares) shifts at the transition to the canted AFM (CA) phase (T_{CA}) and returns to $g \approx 2$ as FM resonance at T_{FM}. At the transition into the FM phase the spectrum changes again, where the second strong resonance (open squares) shifts to high fields due to demagnetization indicating the increase of local magnetic fields in the sample. Remarkably, no such additional FM resonances could be detected above T_c for samples with $x > 0.175$, which already exhibit a FM metallic ground state. Although the co-existence of PM and FM resonances in various manganites was reported previously, an additional FM resonance (solid stars in Fig. 1) in the PM

*Corresponding author. Physics Faculty, Kazan State University, 420008 Kazan, Russia. Tel.: +7 843 231 51 75; fax: +7 843 292 74 18.
E-mail address: Vladimir.Ivanshin@ksu.ru (V.A. Ivanshin).

0304-8853/$ - see front matter
doi:10.1016/j.jmmm.2006.10.913